PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P666PC00	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/DK 03/00443	International filing date *(day/month/year)* 26.06.2003	Priority date *(day/month/year)* 26.06.2002
International Patent Classification (IPC) or both national classification and IPC B01D37/00		
Applicant FORSKNINGSCENTRET FOR SKOV OG LANDSKAB et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 7 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
15.01.2004	11.10.2004
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Nissen, V Telephone No. +49 89 2399-8619

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/DK 03/00443

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1-52 as originally filed

Claims, Numbers

1-51 filed with telefax on 01.10.2004

Drawings, Sheets

1/21-21/21 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☒ the claims, Nos.: 52

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-51
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-51
Industrial applicability (IA)	Yes:	Claims	1-51
	No:	Claims	

2. Citations and explanations

   see separate sheet

Reference is made to the following documents:

D1: US-A-5 772 900 (YOSHIKAWA TAKASHI ET AL) 30 June 1998 (1998-06-30)
D2: US-A-5 295 583 (BISCHOFBERGER ULRICH ET AL) 22 March 1994 (1994-03-22)
D3: GB-A-2 201 355 (ASEA ATOM AB) 1 September 1988 (1988-09-01)

1. The present invention is concerned with a method and a device relying on the principle that entrained objects in a stream travelling in a convective layer may deposit in/on a receiving layer adjacent to the convective layer.

1.1 The present claims have been amended to overcome objections raised by the International Preliminary Examination Authority.

1.1 One amendment concerns the thickness of the convective layer to state that it is between 1 mm and 5 cm. Basis for the amendment is mentioned by the applicant to be page 21, lines 31-35.

1.2 In this respect it is noticed that the range in question is disclosed in respect of filtering liquid and that the following paragraph emphasizes that for filtering gas the dimension is "considerably lower".

1.3 No arguments have been submitted as to why the range in question may be generalised for use in filtering gasses as well as liquids as suggested by present claims 1 and 50.

1.4 Accordingly it appears that a combination of subject matter not foreseen in the originally filed application has been introduced, thus extending the subject matter of the application beyond the original content (Art. 34(2)(b) PCT).

1.5 Moreover, on the basis of the statement on page 22 indicating that the dimension is considerably lower, it would appear that the claims to gas filtration are not sufficiently supported (Art. 5 and 6 PCT) over the entire scope claimed by the disclosure of the application. Vice versa the claims lack essential features necessary and sufficient for ensuring the intended effect (Art. 33 and R. 6.3 PCT).

1.6 Accordingly the present examination can in principle only be carried out for the alternative pertaining to liquid treatment. Nevertheless, as the treatment of gas is considered to be essentially analogous to treatment of liquid, the arguments submitted are found to apply to any treatment of gas as well.

2. The filtering concept addressed by the present application is generally known i.a. in the form of cross-flow filtration. A fluid comprising unwanted substances is led in a first direction parallel to a filtering surface on, in or passed which the substances in question are retained. The substances approaches the filtering surface by a cross-flow perpendicular to the surface.

2.1 A similar concept is known from sedimentation filtration, where entrained substances leaves the convective layer due to gravity and are retained as sediment.

2.2 The International Search Report cites D1-D3 in which known devices relying on such principles are disclosed. For instance D1 discloses two or more parallel channels (chambers 20,22) separated by filtration films and perforated walls (18, 94). The fluid to be filtered is travelling along channel 20 and entrained substances leave through filtration films and perforated walls 18, 94 into channel(s) 22. See for instance fig. 3 and corresponding text.

2.3 In D1 channel 20 could be considered as a "convective layer" and either the filtration films with perforated walls (18, 94) and/or the chamber(s) 22 can be considered as a "receiving layer". Depending on the definition chosen, the chamber(s) 22 can also be seen as additional "convective layers". In D1 the fluid to be treated is a cutting fluid comprising metal chips.

2.4 Nevertheless, D1 does not indicate a thickness of the convective layer to be in the range of 1 mm to 5 cm.

2.5 Also D2 and D3 disclose the use of cross-flow filters. In particular D3 employs a matrix comprising various inorganic compounds as "receiving layer" for clarifying water eg. industrial waste water. Nevertheless, these documents also fail to suggest a convective layer having the dimensions stipulated by the independent claims.

2.6 Accordingly the subject matter of all claims is found novel (Art. 33(2) PCT).

3. Despite the fact that novelty is given, it is not found surprising that it is possible to remove substances entrained in stream by passing it in parallel to a receiving layer. This in particular applies when the receiving layer is placed under the convective layer in a normal gravitational field. Vice versa introducing substances to the stream from the "receiving layer" would be obvious at least when the latter is placed over the prior.

3.1 Accordingly no inventive step can be acknowledged for the independent claims.

3.2 The remaining claims do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

3.3 In said claims only slight constructional change in the subject matter of the independent claims are defined and which come within the scope of the customary practice followed by persons skilled in the art, especially as the advantages thus achieved can readily be foreseen. In other words no surprising effect can be seen to have been appropriately demonstrated for the subject matter as claimed.

3.4 For instance it is common to use filter materials having some sort of affinity to the material to be removed or to use it as substrate for microbes which provide additional removal or decomposition of unwanted substances.

3.5 It is also generally known in the art of filtration to stack filter elements and/or operate such in parallel. It is found obvious that for at least for some filtering purposes a large ratio between conduction in the convective part and retention in the receiving part should be ensured.

3.6 The use and optimisation of various known filter types for various purposes is well within the skills of the person skilled in filtration. This also includes the selection of filter materials as long as these are mere alternatives with no surprising effect attached.

3.7 Consequently, the subject-matter of said claims lacks an inventive step (Art. 33(3) PCT).

4. It is clear from the above the dimension of the convective layer is to be seen as an

essential feature of the present invention. However, due to the at least optionally inhomogeneous nature of the layers in question it may be difficult, if not in some cases even impossible, to determine the actual thickness of the layers in particular at a 1 mm accuracy (Art. 5 and 6 PCT).

4.1 Amended device claim 26 comprises several process features not having any limiting effect on the device per se and rendering the claim inconcise and the actual scope of thereof unclear (Art. 6 PCT).

4.2 In claims 13, 17, 35 and 39 the material mentioned is defined in relative and thus unclear terms (Art. 6 PCT). Moreover, it has rather been defined by desired effects than structural properties (Art. 6 PCT).

4.3 It appears that tradenames have been used for defining the invention in the claims, i.a. claims 9, 15, 16, 32, 37 and 38. The actual product covered by a tradename is subject to change without notice. Accordingly such tradenames are unsuited for defining the subject matter to be protected (Art. 6 PCT).

5. Industrial applicability is self-evident for the subject matter of all claims (Art. 33(4) PCT).

Claims

1. A method for removal or enhancement of a liquid or gas with substances, said method comprising
   i. providing a filter comprising at least one convective layer and at least one receiving layer adjacent one another,
   ii. passing the liquid or gas through the filter so that the main direction of flow is along the layers and the main flow of liquid or gas is in the convective layer, allowing the substances to:
      a) be transferred to a receiving layer, and
      b) be retained within a receiving layer,

      or allowing the substances to:
      c) be released from a receiving layer, and
      d) be transferred from a receiving layer to a convective layer.

2. The method according to claim 1, wherein a receiving layer is positioned below the convective layer to allow particulate substances to sediment into the receiving layer.

3. The method according to any of the preceding claims, wherein the substances are transferred to the receiving layer(s) due to sedimentation, mixing layer mass flow, and/or diffusion.

4. The method according to any of the preceding claims, wherein the substances are retained within the receiving layer by sorption or any other retention mechanism.

5. The method according to any of the preceding claims, wherein the substances are retained within the receiving layer due to absorption, adsorption, precipitation, straining and/or sedimentation

6. The method according to any of the preceding claims, where the receiving layer further has an affinity for the substances.

7. The method according to any of the preceding claims, where the receiving layer comprises at least one micro-organism capable of converting the substances.

8. The method according to claim 7, where the substances move from the receiving layer into a second convective layer adjacent the receiving layer and opposite the first convective layer.

9. The method according to any of the preceding claims, where the filter further comprises a second receiving layer adjacent the convective layer and opposite the first receiving layer.

10. The method according to any of the preceding claims, where at least one receiving layer comprises material selected from the list consisting of sand, gravel, perlite, vermiculite, anthracite, activated carbon, charcoal, limed soil, iron-enriched soil, diatomaceous soil, chitin, chitosan, pozzolan, lime, marble, clay, iron-oxide-coated minerals (e.g. sand), double metal-hydroxides, LECA, rockwool, glasswool, zeolithes, fly ash, soil, humus, bark, lignin, compost, leaves, seaweed, algae, alginate, xanthate, peat moss, bone gelatin beads, moss, wool, cotton, other plant fibres, and modification hereof.

11. The method according to any of the preceding claims, wherein a receiving layer comprises trapped sediment as a sorbent.

12. The method according to any of the preceding claims, wherein the convective layer comprises empty space.

13. The method according to any of the preceding claims 1 to 11, wherein the convective layer comprises a non-absorbent, water-permeable, fibrous mesh material formed with circuitous pathways therethrough.

14. The method according to any of the preceding claims, wherein the convective layer comprises a mass of random filament-type plastic fibers with a density which is sufficient to support the filter unit without significant collapse, but allow water to pass freely therethrough.

15. The method according to claim 14, wherein the convective layer comprises a polyethylene or polyester fibrous mesh.

16. The method according to claim 15, wherein the convective layer comprises ENKADRAIN 8004H/5-2s/D110P manufactured by Colbond Geosynthetics, Arnhem, the Netherlands.

17. The method according to claim 15, wherein the convective layer comprises FIBERBOND EM 6645 manufactured by Fiberbond in Michigan City, Ind.

18. The method according to any of the preceding claims, wherein the convective layer comprises a mass of open-structured plant fibers with a density which is sufficient to support the filter unit without significant collapse, but allow water to pass freely therethrough.

19. The method according to claim 18, wherein the plant fibers comprise a mat of bark, chunk-wood, chip-wood, or straw.

20. The method according to any of the preceding claims, wherein the hydraulic conductivity of the convective layer is at least 1.1 times the hydraulic conductivity of the receiving layer in the main flow direction.

21. The method according to any of the preceding claims, wherein the difference in hydraulic conductivity between the receiving and convective layer along the axis of the main direction of flow in the connective layer is at least a factor 2, more preferably at least a factor 10, more preferably at least a factor 10^2, more preferably at least 10^3, more preferably at least 10^4, such as at least 10^5, for example at least 10^6.

22. The method according to any of the preceding claims, wherein the liquid to be filtered comprises waste water, industrial waste water (pharma, oil, chemical, metal, food and feed industry), urban waste water, highway runoff, stormwater.

23. The method according to any of the preceding claims, wherein the liquid to be filtered comprises urban waste water, highway runoff, road runoff and/or stormwater.

24. The method according to any of the preceding claims, wherein the pollutant is selected from the group consisting of: hydrocarbons, oil, heavy metals, hormones, PAH, pesticides, pharmaceuticals, MTBE, inorganic ions (nitrite, nitrate, phosphate, sodium), colloids below 20 µm, BAM, chlorinated fluids.

25. The method according to claim 1, further comprising passing the liquid or gas through a pre-filter to remove particulate material prior to the removal or enhancement steps.

26. The method according to claim 25, wherein particulate material with a mean size above 250 µm is removed.

27. A filter unit for removal or enhancement of a liquid or gas with substances, said filter unit comprising
   i. at least one convective layer,
   ii. at least one receiving layer adjacent said convective layer,
   iii. at least one impermeable layer preventing the flow of liquid or gas through the layers in a direction perpendicular to the layers and sequentially through the layers.

28. The filter unit according to claim 27, further comprising a second receiving layer adjacent the convective layer opposite the at least one receiving layer, being a sandwich filter.

29. The filter unit according to claim 28, comprising a stack of sandwich filters, the stack comprising at least 2 sandwich filters, such as at least 3 sandwich filters, for example at least 4 sandwich filters, such as at least 5 sandwich filters, for example at least 6 sandwich filters, such as at least 7 sandwich filters, for example at least 8 sandwich filters, such as at least 9 sandwich filters, for example at least 10 sandwich filters, such as at least 12 sandwich filters, for

example at least 15 sandwich filters, such as at least 20 sandwich filters, for example at least 25 sandwich filters.

30. The filter unit according to claim 27, comprising a stack of alternating convective/receiving layers.

31. The filter unit according to claim 30, comprising a stack of at least 2 convective/receiving layers, such as at least 3 layers, for example at least 4 layers, such as at least 5 layers, for example at least 6 layers, such as at least 7 layers, for example at least 8 layers, such as at least 9 layers, for example at least 10 layers, such as at least 12 layers, for example at least 15 layers, such as at least 20 layers, for example at least 25 layers.

32. The filter unit according to claim 27, wherein the impermeable layer surrounds the filter unit to seal it from the surroundings on all surfaces except the inlet and outlet.

33. The filter unit according to any of claim 27 to 32, wherein the receiving layers is selected from the group consisting of sand, gravel, perlite, vermiculite, anthracite, activated carbon, charcoal, soil, limed soil, iron-enriched soil, diatomaceous soil, chitin, chitosan, pozzolan, lime, marble, clay, iron-oxide-coated minerals, e.g. sand, double metal-hydroxides, LECA, rockwool, zeolithes, fly ash, soil, bark, lignin, compost, seaweed, algae, alginate, xanthate, peat moss, bone gelatin beads, moss, wool, cotton, other plant fibres, and modification hereof.

34. The filter unit according to any of claim 27 to 33, wherein a receiving layer comprises trapped sediment as a sorbent.

35. The filter unit according to any of claim 27 to 34, wherein the convective layer consisting of a non-absorbent, water-permeable, fibrous mesh material formed with circuitous pathways therethrough.

36. The filter unit according to any of claim 27 to 35, wherein the convective layer comprises a mass of random filament-type plastic fibers with a density which is

sufficient to support the filter unit without significant collapse, but allow water to pass freely therethrough.

37. The filter unit according to any of claim 27 to 36, wherein the convective layer comprises a polyethylene or polyester fibrous mesh.

38. The filter unit according to any of claim 27 to 34, wherein the convective layer comprises ENKADRAIN 8004H/5-2s/D1/10P manufactured by Colbond Geosynthetics, Arnhem, the Netherlands.

39. The filter unit according to any of claim 27 to 34, wherein the convective layer comprises FIBERBOND EM 6645 manufactured by Fiberbond in Michigan City, Ind.

40. The filter unit according to any of claim 27 to 34, wherein the convective layer comprises a mass of open-structured plant fibers with a density which is sufficient to support the filter unit without significant collapse, but allow water to pass freely therethrough.

41. The filter unit according to claim 40, wherein the plant fibers comprise a mat of bark, chunk-wood, chip-wood, or straw.

42. The filter unit according to any of claim 27 to 41, wherein the hydraulic conductivity of the convective layer is at least two times the hydraulic conductivity of the receiving layer in the main flow direction, more preferably at least ten times.

43. The filter unit according to any of claim 27 to 41, wherein the difference in hydraulic conductivity between the receiving and convective layer along the axis of the main direction of flow in the connective layer is at least a factor 10, more preferably at least a factor 10^2, more preferably at least 10^3, more preferably at least 10^4, such as at least 10^5, for example at least 10^6.

44. The filter unit according to any of claim 27 to 43, being in the form of a roll.

45. The filter unit according to claim 44, having at least two rounds, such as at least 3 rounds, for example at least 4 rounds, such as at least 5 rounds, for example at least 6 rounds, such as at least 7 rounds, for example 8 rounds, such as at least 9 rounds, for example at least 10 rounds, such as at least 12 rounds, for example at least 15 rounds, such as at least 20 rounds, for example at least 25 rounds of receiving/convective layer or receiving/convective/receiving layer.

46. The filter unit according to any of claim 27 to 45, further comprising a pump for pumping liquid or gas through the filter unit.

47. The filter unit according to any of claim 27 to 46, further comprising a pre-filter adapted to remove particulate material from the liquid or gas prior to passing the liquid or gas into the filter.

48. The filter unit according to claim 47, wherein the pre-filter is adapted to remove particles above 250 µm.

49. Use of the filter unit according to claims 27 to 48 for filtering wastewater.

50. The use of claim 49, wherein the wastewater is stormwater runoff, stormwater drain, highway runoff, urban runoff, urban stormwater.

51. Use of the filter unit according to claims 27 to 50 for filtering gas (flue gas, waste gas, exhaust gas).

52. Use of the filter unit according to claims 27 to 47 for filtering oil.